Transition metal dichalcogenide nanotubes

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Due to their favorable and rich electronic and optical properties, group-VI-B transition-metal dichalcogenides (TMDs) have attracted considerable interest. They have earned their position in the materials portfolio of the spintronics and valleytronics communities. The electrical performance of TMDs will be enhanced by rolling up the two-dimensional (2D) sheets to form quasi-one-dimensional (1D) tubular structures. Actually, the TMD nanotubes were first synthesized back in 1992 [1], but only recently device related researches have been conducted [2].In this presentation, we discuss transport and optoelectronic properties ranging from field effect transistor (FET) operation to solar cell actions in tungsten disulfide multiwalled nanotubes (WS_2-NT).

We first fabricated electric double layer transistor (EDLT) of an individual WS_2-NT and found an ambipolar operation, in sharp contrast to the solid gated FET devices which exhibits only n-type conduction. Furthermore, we found that gating with $KClO_4$/polyethylene glycol electrolyte, induce superconductivity at T_c = 5.8 K. This is the first superconductivity in the individual nanotube structure. Importantly, this superconductivity of gated WS_2 exhibited peculiar transport properties arising only from tublar and chiral structure [3].

Using the EDLT devices, we were able to fabricate a p-n junction in an individual WS_2-NT, and found that this p-n junction shows current-driven light emission, and photovoltaic actions. Both of these actions are linearly polarized along the NT axis, and more importantly, the *external* quantum efficiency for the photovoltaic effect reaches a value as high as 4.8%, exceeding by far that of 2D TMDs and even approaching the internal quantum efficiency of the 2D TMDs [4].

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